

**PATENT**

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE  
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES**

Application No.: 10/689,198  
Filing Date: October 20, 2003  
Applicant: Joseph D. Rainville et al.  
Group Art Unit: 1795  
Examiner: Alix Elizabeth Echelmeyer  
Title: REGENERATIVE COMPRESSOR MOTOR CONTROL FOR  
A FUEL CELL POWER SYSTEM  
Attorney Docket: 8450G-000213 (General Motors Docket No. GP-303508)

---

Mail Stop Appeal Brief - Patents  
Commissioner for Patents  
P.O. Box 1450  
Alexandria, Virginia 22313-1450

**SECOND APPEAL BRIEF UNDER 37 CFR § 41.37**

This is an appeal from the Office Action mailed March 31, 2011, which was made in response to Applicants' Appeal Brief filed September 30, 2010. A new Notice of Appeal is filed with this brief; it is due without extension by June 30, 2011.

No fee is due for the Notice of Appeal or this Brief, as Applicants have elected to maintain the appeal for which these fees have already been paid.

Although the latest (and ninth) Office Action on the merits was not final, appeal is proper because the claims have been at least twice rejected.

## **TABLE OF CONTENTS**

	<b><u>Page</u></b>
Real Party in Interest.....	1
Related Appeals and Interferences .....	1
Status of the Claims .....	1
Status of Amendments.....	1
Summary of Claimed Subject Matter .....	2
Grounds of Rejection to be Reviewed on Appeal.....	5
Arguments ... ..	6
Introduction	
I. ....	8
II. ....	12
III. ....	17
Conclusion .....	20
Claims Appendix .....	21
Evidence Appendix .....	24
Related Proceedings Appendix .....	25

## **TABLE OF AUTHORITIES**

### **Page**

Phillips v . AWH Corporation 415 F.3d 1303, 1313 (Fed. Cir. 2005) .....	8, 12
Trintec Industries, Inc. v. Top-U.S.A. Corporation 295 F.3d 1292, 1295 (Fed. Cir. 2002).....	15
Richo Co., Ltd. V. Quanta Computer Inc. 550 F.3d 1325, 1332 .....	19

### **Real Party in Interest**

The real party in interest is GM Global Technology Operations, Inc., which acquired the interest in an assignment recorded with the U.S. Patent and Trademark Office January 13, 2009 at Reel 22092, Frame 0737.

### **Related Appeals and Interferences**

There are no other appeals, interferences, or judicial proceedings which will directly affect or be directly affected by or have a bearing on the Board's decision in this appeal.

### **Status of the Claims**

Claims 10, 17, and 20-26 are pending, are rejected, and are appealed. Claims 1-9, 11-16, 18, and 19 have been cancelled.

### **Status of Amendments**

No claims were amended after the final rejection.

### **Summary of Claimed Subject Matter**

Claims 10 and 21 are independent claims. Claims 17 and 20 depend on claim 10; claims 22-26 depend on claim 21.

#### **Independent Claim 10**

Independent claim 10 claims a fuel cell system, comprising a fuel cell 26 that processes an oxidant to produce electrical energy

*(page 1, lines 9-12 (beginning of ¶2)); Figure 1, showing air entering compressor, then fuel cell stack; page 4, lines 5-12 (¶18))*

and a variable capacity compressor system that supplies the oxidant to the fuel cell:

*(Figure 2; page 2, lines 6-8 (first sentence, ¶5); page 3, lines 19-20 (¶15)).*

During operation, the variable capacity compressor system supplies the oxidant by operating in a mode selected from a normal mode below a threshold rate of 40%/s change in capacity and a rapid transient mode selected from an upward and downward variation at or above the threshold rate

*(page 2, lines 13-16 (¶¶6,7); page 4, line 16-page 5, line 13 (¶¶19,20); page 7, lines 7-14 (first half ¶25)).*

The variable capacity compressor system comprises a compressor 14, 34 that compresses the oxidant

*(page 2, lines 8-10 (beginning ¶5); page 3, lines 9-12 (last sentence, ¶12);*

*Fig. 1 & page 4, lines 6-8 (in ¶18), Fig. 2),*

a compressor motor 32 that drives the compressor 14, 34

*(Fig. 2 & page 6, lines 21-22 (first sentence, ¶24)),*

and a controller 30 that monitors a power demand from said fuel cell and that selects a power source for the compressor motor 34

*(Fig. 2 & page 7, lines 1-19 (§§24, 25)).*

The power source is either a main power source 22 when operating in normal mode or a supplemental power source 24 when operating in rapid transient mode which is upward

*(page 2, lines 10-12 (last sentence, §5); page 5, lines 14-20 (§§21, 22); page 6, lines 7-10 (first sentence, §23); Fig. 1, power system 20 having main power source 22 and supplemental power source 24; Fig. 2, showing main and supplemental sources; Fig. 3, elements 301 & 304, elements 301, 302 & 308, and elements 301, 302 & 306; page 7, line 7-page 8, line 10 (§§ 25, 26)).*

The controller also controls charging of the supplemental power source comprising regenerative braking of the motor that converts mechanical energy into charging current

*(page 3, lines 1-3; page 6, lines 14-17 (in §23); page 7, last line-page 8, line 2; Fig. 3, elements 301 & 304).*

The supplemental power source is selected from capacitors and supercapacitors

*(page 2, lines 17-18 (§8); page 5, line 19-page 6, line 6 (§22)).*

## Independent Claim 21

Claim 21 claims a method of operating a fuel cell system. The fuel cell system comprises a variable capacity compressor system, which in turn comprises a variable capacity compressor 14, 34 that supplies an oxidant to fuel cells of the fuel cell system while the fuel cell system operates

*(page 2, lines 8-10 (beginning ¶5); page 3, lines 9-12 (last sentence, ¶12);*

*Fig. 1 & page 4, lines 6-8 (in ¶18); Fig. 2; page 2, lines 6-8 (first sentence, ¶5); page 3, lines 19-20 (¶15))*

and a compressor motor 32 that drives the compressor 14, 34

*(page 2, lines 8-10 (¶5, second sentence); Fig. 2 & page 6, lines 21-22 (¶24, first sentence)).*

The method of operating the fuel cell system comprises:

operating the variable capacity compressor in a normal mode at a first capacity of the fuel cell system to produce electrical power,

*(page 4, lines 5-12 (¶18); page 7, lines 7-17 (¶25));*

powering the compressor motor from a main power source during said normal mode,

*(page 2, lines 10-12 (¶5, last sentence); page 6, lines 7-9 (¶23, first sentence); page 8, lines 7-10; Fig. 3, elements 301, 302 & 308);*

adjusting the variable capacity compressor from the first capacity to a second capacity of the fuel cell system to produce electrical power when in a rapid transient mode at or above a threshold rate of 40%/s change in capacity,

*(page 2, lines 15-16 (¶7); page 5, lines 3-13 (¶20); page 7, lines 7-17 (¶25));*

and, when in the rapid transient mode either:

a) powering the compressor motor from a supplemental power source when the rapid transient mode is an upward rapid transient mode

*(page 2, lines 10-12 (¶5, last sentence); page 6, lines 7-10 (¶23, first sentence) page 7, lines 7-17 (¶25); page 8, lines 4-7),*

or

b) regeneratively braking the compressor motor to produce charging current for said supplemental power source when operating in said rapid transient mode which is a downward rapid transient mode

*(page 3, lines 1-3; page 6, lines 14-17 (in ¶23); page 7, last line-page 8, line 2; Fig. 3, elements 301 & 304).*

#### **Ground of Rejection to be Reviewed on Appeal**

Claims 10, 17, and 20-26 stand rejected under 35 U.S.C. § 103(a) as unpatentable over Aberle et al., U.S. Patent Application Publication 2003/0077494, in view of Raiser et al, U.S. Patent Application Publication 2002/0064695 and Lahiff, U.S. Patent Application Publication 2003/0068538.



## Argument

### Introduction

An examiner bears the initial burden of establishing prima facie obviousness “on the totality of the record, by a preponderance of the evidence with due consideration to the persuasiveness of argument.” *Ex Parte Frye*.<sup>1</sup> An obviousness rejection can be overcome by showing an error in a finding of fact necessary to support the obviousness rejection or an error in the reasoning supporting the conclusion of obviousness.<sup>2</sup>

Here, the rejection should be reversed because any one of three key factual and legal findings is not supported by a preponderance of the evidence in the record:

- (1) The evidence in the record does not support a conclusion that the prior art discloses or provides a reason to include the **“selection” claim elements**: *“a controller that monitors a power demand from said fuel cell and that selects a power source for said compressor motor, said power source being either a main power source when operating in said normal mode or a supplemental power source when operating in said rapid transient mode which is upward”* in claim 10 and *“powering the compressor motor from a main power source during said normal mode . . . powering the compressor motor from a supplemental power source when said rapid transient mode is an upward rapid transient mode”* in claim 21.

These claim elements call for a fuel cell system with a controller that during operation selects a main power source or a supplemental power source in the alternative,

---

<sup>1</sup> Appeal 2009-006013, slip op. at 8-9 (BPAI Feb. 26, 2010) (precedential) (quoting *In re Oetiker*, 977 F.2d 1443, 1445 (Fed. Cir. 1992) and citing and quoting *In re Piasecki*, 745 F.2d 1468, 1472 (Fed. Cir. 1984) (the initial burden of proof is on the USPTO “to produce the factual basis for its rejection of an application under sections 102 and 103”).

<sup>2</sup> *Id.*, slip op. at 9.

depending on the compressor's mode (claim 10) and a method of operating a fuel cell system in this way (claim 21).

- (2) The evidence in the record does not support a conclusion that the prior art discloses the **“switching at a threshold rate of 40%/s change in capacity”** claim elements: *“said power source being . . . a supplemental power source when operating in said rapid transient mode which is upward”* in claim 10 and *“powering the compressor motor from a supplemental power source when said rapid transient mode is an upward rapid transient mode”* in claim 21.

These claim elements call for a switching from one power source to an alternate power source when the threshold rate indicating rapid transient mode is attained (i.e., switching from the main power source in normal mode to the supplemental power source in rapid upward transient mode) and when normal mode is again established (i.e., switching back to the main power source). In fuel cell system claim 10, the controller has this function; in the method claim 21, these are steps of the method.

- (3) The evidence in the record and the Examiner's rationale do not support a conclusion that the **“regeneratively braking the compressor motor”** claim elements would be obvious from the Lahiff patent's vehicle regenerative braking when the Lahiff patent teaches using its compressor to dissipate, or waste energy.

**I. In Appellants' claims, the compressor motor is powered by either a main power source or a supplemental power source (the "selection" claim elements). In the cited Aberle publication the main power source and supplemental power sources are used together when more power is needed, and the Raiser patent, which teaches using a battery during start-up when the main power source (fuel cell) is not available, provides no reason to alter the Aberle use.**

*A. Claim interpretation of Appellants' terms "said power source being either a main power source . . . or a supplemental power source" from claim 10 and "powering the compressor motor from a main power source during said normal mode . . . powering the compressor motor from a supplemental power source when said rapid transient mode is an upward rapid transient mode" from claim 21*

Claim terms are construed by how a person of ordinary skill in the art would understand the claim terms as they are used in the claims in light of the specification as a whole. *Phillips v. AWH Corporation*<sup>3</sup> First, the claim language itself ("either . . . or" and "powering the compressor motor from a main power source" in one mode and "from a supplemental power source" in the other mode) indicates alternative use of the main power source and the supplemental power source.

The specification also teaches alternative use, depending on the mode, as shown in Figure 3 (main power source used in box 308, supplemental power source used in box 306) and as described in paragraphs 5 ("A controller powers the motor from a main power source when operating in the normal mode and powers the motor from a supplemental power source when operating in the rapid transient mode."), 23 ("the compressor 14 is powered by the main power source 22 during normal operation and the supplemental power source 24 during rapid upward transient operation"), 25 ("The compressor controller 30 determines to draw power from the main power source 22 during operation in the normal mode and draws power form the supplemental power source 24 during operation in the rapid upward transient mode."), and 26 ("If the transient request is greater than the threshold, control cooperates the fuel cell system 10

in the rapid transient mode, powering the compressor motor 32 using the supplemental power source 24 in step 306 and control ends. If the transient request is not greater than the threshold, control operates the fuel cell system 10 in the normal mode, powering the compressor motor 32 using the main power source 22 in step 308 and control ends.”).

The last sentence in paragraph 25 states that it is possible to draw power from both the main and supplemental power sources in an upward rapid transient, but this feature is omitted from each of the present claims.

Accordingly, if, on the totality of the record, the prior art teaches that both the main power source and the supplemental power source together to power a compressor motor when a normal mode of operation is followed by a demand for increased oxidant, it is not obvious to operate with only the supplemental power source. Further, if Raiser teaches using a supplemental power source alone during start-up because the main power source (the fuel cell itself) isn’t available until after start-up, then it gives no reason to alter how the power sources are used in Aberle after the fuel cell is started and operating.

Appellants believe this to be the case for the references cited in this rejection, as will now be explained.

---

<sup>3</sup> 415 F.3d 1303, 1313 (Fed. Cir. 2005) (en banc).

*B. The references cited by the Examiner do not show that the selection claim elements are found in the prior art. The Examiner admits this feature is absent from the Aberle publication, and the start-up method in the Raiser provides no reason to alter the Aberle fuel cell system operation after start-up.*

The Aberle publication never uses a supplemental power source alone to power a compressor motor. The Aberle publication describes a fuel cell 2 that supplies current to electric motor 7, responsible for the traction drive of the vehicle.<sup>4</sup> Motor 7 drives the compressor as well.<sup>5</sup> In the Aberle system, illustrated by Fig. 3, curve 12 is the target power demand as a function of time and curve 13' is the power available from the fuel cell as a function of time. Small, initial bump 16 is "a power burst 16 [] released from energy storage device 8 to drive 5 of compressor 4."<sup>6</sup> Immediately after this small burst, and well before the change in capacity again levels out to the new, higher power level, the power from energy storage device 8 is diverted from the compressor drive to the electric traction motor 7, shown as second power burst 17:

As soon as available power 13 from fuel cell 2 starts to increase, the power provided from energy storage device 8 to drive 5 of compressor 4 is reduced. . . . As soon as fuel cell 2 increases its delivery of power, the conventional method described above is used—that is, the power shortage between the target power demand 12 and available power 13' is compensated by energy storage device 8, in the form of a second power burst 17, delivered this time to electric traction motor 7.<sup>7</sup>

The Aberle publication teaches two things here. First, the main power source is used continuously to run the compressor motor, and the supplemental power source is added to it only at a beginning of increased power demand to give the small power boost 16. Second, use of the supplemental power source is not based upon whether the compressor is operating at or above a threshold rate of 40%/s change in capacity, because (as is disclosed in the paragraph just quoted and as can be see in Fig. 3)

---

<sup>4</sup> Aberle, page 2, ¶[0016], lines 9-13 from the top of the page & Fig. 1.

<sup>5</sup> Aberle, page 2, ¶[0017], lines 12-18.

<sup>6</sup> Aberle, page 2, ¶[0017], last two lines.

the change in capacity continues to increase after the Aberle supplemental power source is switched from the compressor motor 5 to the vehicle's traction motor 7. Accordingly, the Aberle publication fails to teach both the "selection" and the "switching at a threshold rate of 40%/s change in capacity" claim elements.

Addressing first the "selection" claim element of Appellants' claims, the Examiner admits that the Aberle publication does not disclose this claim element<sup>8</sup> but turns to the Raiser patent, which uses a supplemental power source alone to start the fuel cell up. The Raiser patent, however, does not supply any reason to alter the Aberle fuel cell system or method of operation once the fuel cell is operating. Instead, "after the starting of the fuel cell system and the production of electrical energy by the fuel cell system, the apparatus is subsequently operated with high voltage energy from the fuel cell system."<sup>9</sup>

The Raiser patent uses a low voltage battery at start-up, but during once operating, the compressor motor is driven by electrical energy from the fuel cell system itself.<sup>10</sup> The battery is needed for start-up because the fuel cell system can provide no electrical energy before it is running. The Raiser patent makes no mention of using its low voltage battery after start-up.

A modification of the Aberle fuel cell by combining with it the Raiser start-up method would only lead one of ordinary skill in the art to put Aberle's energy storage device during start-up in the manner described in the Raiser patent.

Thus, taken altogether, the evidence of record does not support a finding that the "selection" claim elements are obvious.

---

<sup>7</sup> Aberle, page 2, ¶[0022].

<sup>8</sup> Office Action dated 3/31/2011, page 5.

<sup>9</sup> Raiser, col. 4, ll. 16-20. See also Abstract ("The drive system includes an electric motor that drives the compressor. During normal operation of the fuel cell system, the motor is fed with electrical energy from the fuel cell system.").

**II. The prior art does not make it obvious to switch to a supplemental power source based on a rapid upward rapid transient mode with a threshold rate of 40%/s change in capacity.**

*A. Interpretation of "rapid transient mode"*

Again employing the principles of claim construction from *Phillip*<sup>11</sup>, the specification describes compressor capacity as the rate at which the compressor supplies oxidant to the fuel cell. ¶3, lines 4-6. An upward transient response time is the time required for a change in the capacity (or oxidant supply rate). ¶4, lines 1-2. Thus, capacity is rate of supply of oxidant, or velocity of air supply, while the transients are the rates of change of capacity, the change in velocity of air supply or acceleration of air supply. See also ¶¶6 (change from a first to a second capacity), 10 (increase in motor speed, which is acceleration) 20 (change in capacity/second). The "normal mode" can be at any capacity—whether high or low velocity of air—so long as the change in capacity is less than the 40%/s change in capacity defined as the threshold for a rapid transient mode.

The claim language itself speaks of the controller selecting a power source based on a threshold change in capacity of the compressor defining the rapid transient mode. The controller of claim 10 selects a supplemental power source for the compressor motor when the rapid transient mode is upward and a main power source when in a normal mode. Similarly, claim 21 recites powering the compressor motor from a main power source during said normal mode and powering the compressor motor from a supplemental power source in an upward rapid transient mode. The specification also teaches that the rapid transient mode lies between a normal mode of a first compressor capacity and a normal mode of a second compressor capacity. ¶[0007] ("the controller operates the motor to transfer from a first capacity to a second capacity when in

---

<sup>10</sup> Abstract.

the rapid transient mode”); ¶[0019] (“While operating in the normal mode, the compressor capacity remains relatively constant or with capacity changes below a corresponding upward or downward threshold rate.”); ¶[0025] (“The compressor controller 30 determines to draw power from the main power source 22 during operation in the normal mode and draws power from the supplemental power source 24 during operation in the rapid upward transient mode.”); ¶[0025] & Fig. 3 (control logic of the controller of the fuel cell system and its operation in the method of operating the fuel cell system).

The claims, then, are directed to a fuel cell system with a controller that selects a power source depending on whether the compressor motor is operating in a normal mode below a threshold rate of 40%/s change in capacity or an upward rapid transient mode at or above the threshold rate, and to a method of operating a fuel cell system including powering the compressor motor from a main power source during said normal mode and powering the compressor motor from a supplemental power source in the upward rapid transient mode. The power source used depends on the rate of change in capacity.

Accordingly, if, on the totality of the record, the prior art only teaches that a supplemental power source alone to power a compressor motor only during start-up and at low speeds of rotation, when a main power source is unavailable, switching to the main power source as soon as the main power source is available and to operate with high voltage energy, then it gives no reason to rely solely on the supplemental power source at any time after the fuel cell is operating, let alone during times when there is a sudden demand to increase capacity (the threshold rate of 40%/s change in capacity).

---

<sup>11</sup> *Id.*



And if the prior art powers the fuel cell compressor motor with a supplemental power source only in conjunction with a main power source and only briefly at the beginning of an upward rapid transient mode, then prior art gives no reason to alternate between a main power source and a supplemental power source based on a threshold rate of 40%/s change in capacity. Appellants believe this to be the case for the references cited in this rejection, as will now be explained.

*B. The Aberle use of the supplemental power source is not based upon whether the compressor is operating at or above a threshold rate of 40%/s change in capacity and the Raiser method only uses its battery at start-up and at "low speeds of rotation." Further, the mere fact that a compressor can operate at different speeds of rotation compels it to be powered by any particular power source at any particular rate of change in capacity.*

The Aberle patent uses a small, initial "power burst 16 [] released from energy storage device 8 to drive 5 of compressor 4."<sup>12</sup>, but immediately after this small burst, and well before the change in capacity again levels out to the new, higher power level, the power from energy storage device 8 is diverted from the compressor drive to the electric traction motor 7. In the passage quoted from Aberle on page 10, above, and as can be seen in Aberle's Figure 3, use of the supplemental power source is not based upon whether the compressor is operating at or above a threshold rate of 40%/s change in capacity. Instead, the change in capacity continues to increase after the Aberle supplemental power source is switched from the compressor motor 5 to the vehicle's traction motor 7. The Aberle publication does not teach the "switching at a threshold rate of 40%/s change in capacity" claim element.

The Raiser low voltage battery only drives the compressor motor "at least at low speeds of rotation, to produce an adequate airflow in order to start the fuel cell system." Col. 2, ll. 23-

25. The Raiser low voltage battery is never used when there is an upward rapid transient mode or at any other time during fuel cell operation.

Thus, the cited combination of references does not make obvious claim 10's "controller that monitors a power demand from said fuel cell and that selects a power source for said compressor motor, said power source being either a main power source when operating in said normal mode or a supplemental power source when operating in said rapid transient mode which is upward" or claim 21's "powering the compressor motor from a main power source during said normal mode . . . powering the compressor motor from a supplemental power source when said rapid transient mode is an upward rapid transient mode."

The Examiner argues that "it would have been obvious to the skilled artisan that this threshold rate [40%/s change in capacity] is an inherent property of the compressor . . . ." Office Action dated 3/31/2011, page 4. Appellants respectfully disagree.

To be inherent, a feature must be "necessarily present," not merely probably or possibly present, in the prior art. *Trintec Industries, Inc. v. Top-U.S.A. Corporation*<sup>13</sup>. The "switching at a threshold rate of 40%/s change in capacity" claim element of claim 10 and its dependent claims is a feature of the controller, not of the compressor: "a controller that monitors a power demand from said fuel cell and that selects a power source for said compressor motor, said power source being either a main power source when operating in said normal mode or a supplemental power source when operating in said rapid transient mode [at or above the threshold rate of 40%/s change in capacity] which is upward." Similarly, in claim 21 and its dependent claims, nothing about a compressor compels it to

---

<sup>12</sup> Aberle, page 2, ¶[0017], last two lines.

<sup>13</sup> 295 F.3d 1292, 1295 (Fed. Cir. 2002) (quoting *In re Robertson*, 169 F.3d 743, 745 (Fed. Cir. 1999)).

be operated in such a way, “powering the compressor motor from a main power source during said normal mode” and “powering the compressor motor from a supplemental power source when said rapid transient mode is an upward rapid transient mode.” It is but one possible way to operate the compressor of a fuel cell system. The Aberle method, for instance, is an alternate way to operate a fuel cell system that adds a supplemental power source for but a fraction of a period of an upward change in capacity, beginning and ending use of the supplemental power source without consideration of the specific rate of change in capacity so long as it is increasing.

The Examiner further argues that a threshold rate of 40%/s change in capacity “is also based on the power provided to the compressor during normal operation.” Office Action dated 3/31/2011, page 4. With due respect, I do not know what this is supposed to mean with regard to the “switching at a threshold rate of 40%/s change in capacity” claim element. It is not a basis for inherency of this element, however. A possibility is insufficient for inherency to hold.

The evidence on record does not support a finding that it would be obvious to alter the Aberle fuel cell system and method to include Appellants’ “switching at a threshold rate of 40%/s change in capacity” claim elements.

**III. Lahiff's regenerative vehicle braking is not similar to Appellants' claim feature of regenerative braking the compressor motor; the devices are not similar; the similar device in Lahiff, Lahiff's compressor motor, is not modified in this way. Thus, there is no reason to modify the Aoyagi fuel cell power supply as the Examiner proposes because only Appellants, and not the prior art, teaches such a modification.**

*A. Evidence of record on this issue*

The Declaration of Joseph D. Rainville Under 37 C.F.R. § 1.132, ¶3, discusses the Lahiff vehicle system:

The Lahiff application teaches to operate a fuel cell system's electric motor-powered air compressor in a very inefficient manner to dissipate or waste excess electrical power generated by an electric vehicle's regenerative braking system. Electric vehicles typically have the ability to reverse the direction of energy flow in the vehicle's main drive or traction motor. Normally the main drive or traction motor converts electric power into mechanical torque to accelerate the vehicle. During vehicle braking or slowing conditions, the motor can reverse that process to convert mechanical torque to electric power that is typically stored in an on board battery or other electrical storage device. This is done to make the vehicle more energy efficient. Lahiff teaches that when more electrical energy is produced by this method than can be stored on board the vehicle this excess power is sent to the on board fuel cell's air compressor to be converted to mechanical energy as air pressure and flow. This air flow is dumped overboard using a system of valves bypasses the fuel cell stack. Alternately, Lahiff also teaches that if the minimum power request from the vehicle is lower than the minimum power that can be produced by the fuel cell system, the vehicle dissipates the excess power by sending to the air compressor, converting it into air pressure and flow that it vents overboard. Lahiff does not teach or imply any mechanism to reclaim mechanical energy of the spinning compressor as our invention does. Only our invention reclaims this energy by regeneratively controlling the compressor motor of a fuel cell system to allow the reclaimed mechanical energy converted to electrical energy to be available to the compressor for the next increase in RPM or speed. Lahiff only teaches to run the compressor in an inefficient manner to waste energy, not to conserve it.

Paragraph 5 adds:

. . . The Lahiff application does not state or imply using the compressor-motor unit to create or store electrical energy, only to dissipate excess electrical energy by converting it to air flow and pressure in the air compressor to then vent this flow and pressure overboard.

The Examiner's statement on page 6 of the office communication dated 2/18/2009 that "So, the compressor of Lahiff et al. is certainly used to generate electricity as well as dissipate it" is not accurate. The Examiner then directs us to see the second sentence of [0011] of the Lahiff application. To quote the first three sentences of paragraph [0011] of Lahiff for context, Lahiff says, "According to one embodiment of the present invention, a method for dissipating electrical power output in a fuel cell power system is disclosed. The fuel cell power system includes a fuel cell stack for generating electric power and a compressor for delivering gas containing oxygen to the fuel cell stack. The method includes the steps of determining an amount of electrical power to be dissipated, operating the compressor to draw electrical current as required to dissipate the power, and valving the compressor to reduce the delivery of gas containing oxygen to the fuel cell stack." I see no teaching or reference to the compressor being used to create or return electrical power to the system, only to consume it. In the Lahiff fuel cell system, electric power is generated with either the vehicle regenerative braking system, or the fuel cell stack generates electric power, and that is by the chemical reaction of oxidant and fuel, not by regenerative control of the compressor motor to convert mechanical energy into electricity.

*B. The Lahiff publication does not teach to conserve the energy of its compressor, but rather to use its compressor to dissipate, or waste energy. Moreover, the method by which the Lahiff vehicle is regeneratively braked is inapplicable to a compressor motor; a compressor motor is not a device similar to a vehicle with brakes. At most, a combination of Lahiff's regenerative braking would make obvious regenerative braking of the Aoyagi vehicle to charge its battery; this does not result in Appellants' claimed fuel cell system or method.*

Finally, the rejection relies on the Lahiff publication as allegedly showing the regenerative braking feature of the claims.

The combined references provide no reason to modify the Aberle system to maintain a supplemental power source at least in part by recapturing energy from the very compressor that it powers in an upward rapid transient mode. The Lahiff publication uses its fuel cell compressor to dissipate ("waste") excess electrical power, as described in the passages above from Mr. Rainville's Declaration.

The Lahiff dissipation of energy is the opposite of Appellants' intentional energy conservation in recovering energy from the fuel cell compressor. The Lahiff publication teaches away from Appellants' invention, and thus does not make Appellants' invention obvious. "A reference may be said to teach away when a person of ordinary skill, upon reading the reference, would be discouraged from following the path set out in the reference, *or would be led in a direction divergent from the path that was taken by the Appellant.*" *Ricoh Co., Ltd. v. Quanta Computer Inc.*<sup>14</sup> The skilled artisan would simply not turn to the Lahiff publication in the first place for a method of conserving the energy of the compressor motor; there would be no expectation of a successful modification based on Lahiff's intentional energy dissipation.

The Examiner argues that one of ordinary skill in the art would recognize that regenerative braking of a motor could charge a battery so that energy wasted during braking could be conserved. First, Lahiff expressly teaches a different use for its compressor motor, that of *dissipating*, not conserving energy. Second, as Mr. Rainville describes, "During vehicle braking or slowing conditions, the motor can reverse that process to convert mechanical torque to electric power that is typically stored in an on board battery or other electrical storage device. This is done to make the vehicle more energy efficient. Lahiff teaches that when more electrical energy is produced by this method than can be stored on board the vehicle this excess power is sent to the on board fuel cell's air compressor to be converted to mechanical energy as air

---

<sup>14</sup> 550 F.3d 1325, 1332 (Fed. Cir. 2008) (quoting *In re Kahn*, 441 F.3d 977, 990 (Fed. Cir. 2006)) (emphasis added). The Board is referred also to *Ex parte Jellá*, 2008-1619 (BPAI 2008) (precedential) which states the law in this way: "A reference may be said to teach away when a person of ordinary skill, upon reading the reference, . . . would be led in a direction divergent from the path that was taken by the applicant." *In re Haruna*, 249 F.3d 1327, 1335 (Fed. Cir. 2001) (quoting *Tec Air, Inc. v. Denso Mfg. Mich. Inc.*, 192 F.3d 1353, 1360 (Fed. Cir. 1999))."

pressure and flow. This air flow is dumped overboard using a system of valves bypasses the fuel cell stack.” Thus, the devices (vehicle, air compressor motor) are not similar in Lahiff, nor are they similarly used. If anything, a modification of the Aberle system according to Lahiff would result in addition of regenerative braking of Aberle’s vehicle coupled with the Lahiff energy dissipation system involving the air compressor. It would not result in Appellants’ invention.

Still yet, nothing in the combined references teaches using the same supplemental power source charged by regenerative braking of the compressor to power the compressor in a rapid upward transient mode.

### **Conclusion**

Accordingly, Appellant respectfully requests that the Board reverse the rejection of claims 10, 17, and 20-26.

Should communication by telephone be needed or helpful, the undersigned can be reached at (248) 641-1220 (direct line).

Respectfully submitted,

Dated: June 28, 2011

By: /Anna M. Budde/  
Anna M. Budde  
Reg. No. 35,085

**CORRESPONDENCE ADDRESS:**  
Harness, Dickey & Pierce, P.L.C.  
P.O. Box 828  
Bloomfield Hills, Michigan 48303  
(248) 641-1600

## Claims Appendix

10. A fuel cell system, comprising:

a fuel cell that processes an oxidant to produce electrical energy;

a variable capacity compressor system that supplies said oxidant to said fuel cell and that during operation of the fuel cell system, supplies said oxidant by operating in a mode selected from a normal mode below a threshold rate of 40%/s change in capacity and a rapid transient mode selected from an upward and downward variation at or above the threshold rate, said variable capacity compressor system comprising:

a compressor that compresses said oxidant; and

a compressor motor that drives said compressor

a controller that monitors a power demand from said fuel cell and that selects a power source for said compressor motor, said power source being either a main power source when operating in said normal mode or a supplemental power source when operating in said rapid transient mode which is upward wherein said supplemental power source is selected from capacitors and supercapacitors and wherein said controller controls charging of said supplemental power source comprising regenerative braking of the motor that converts mechanical energy into charging current.

17. The fuel cell system of claim 10 wherein charging further comprises using power generated by said fuel cell.

20. The fuel cell system of claim 10 wherein said controller shifts said variable capacity compressor between said normal mode and said rapid transient mode based on said power demand.



21. A method of operating a fuel cell system comprising a variable capacity compressor system, comprising a variable capacity compressor that supplies an oxidant to fuel cells of the fuel cell system while the fuel cell system operates and a compressor motor that drives the compressor, the method comprising:

operating said variable capacity compressor in a normal mode at a first capacity of the fuel cell system to produce electrical power;

powering the compressor motor from a main power source during said normal mode;

adjusting said variable capacity compressor from said first capacity to a second capacity of the fuel cell system to produce electrical power when in a rapid transient mode at or above a threshold rate of 40%/s change in capacity; and

when in said rapid transient mode either:

a) powering the compressor motor from a supplemental power source when said rapid transient mode is an upward rapid transient mode, or

b) regeneratively braking the compressor motor to produce charging current for said supplemental power source when operating in said rapid transient mode which is a downward rapid transient mode.

22. The method of claim 21 wherein said second capacity is greater than said first capacity when operating in said upward rapid transient mode.

23. The method of claim 21 wherein said second capacity is less than said first capacity wherein operating in said downward rapid transient mode.

24. The method of claim 21 wherein said supplemental power source is a capacitor.
25. The method of claim 21 further comprising charging said supplemental power source during said normal mode.
26. The method of claim 21 further comprising using power from said supplemental power source to increase speed of the compressor motor when in said upward rapid transient mode.

### **Evidence Appendix**

Declaration of Joseph D. Rainville Under 37 C.F.R. § 1.132, entered with Request for Continued Examination and Submission Under 37 C.F.R. § 1.114 submitted April 22, 2009.

**Related Proceedings Appendix**

None

**PATENT**

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

Application No.: 10/689,198  
Filing Date: October 20, 2003  
Applicant: Joseph D. Rainville et al.  
Group Art Unit: 1795  
Examiner: Alix Elizabeth Echelmeyer  
Title: REGENERATIVE COMPRESSOR MOTOR CONTROL FOR  
A FUEL CELL POWER SYSTEM  
Attorney Docket: 8450G-000213 (General Motors Docket No. GP-303508)

---

Commissioner for Patents  
P.O. Box 1450  
Alexandria, Virginia 22313-1450

**Declaration of Joseph D. Rainville Under 37 C.F.R. § 1.132**

I, Joseph D. Rainville, declare:

1. I am the first inventor named in this patent application. I have been a practicing Hydrogen Fuel Cell Engineer since October 21<sup>st</sup> of 1996. I graduated from Rochester Institute of Technology in 1994 with a BS degree in Mechanical Engineering Technology. I continued my education with air compressors and turbomachinery by enrolling in the "Fluid Mechanics of Turbomachines" class at Rochester Institute of Technology in 2002, in addition to a graduate level class in "Centrifugal Compressor Design and Performance" taught by Dr. David Japikse at Concepts NREC (Northern Research and Engineering Corp) of White River Junction, VT. I am

an inventor of four issued patents and fourteen patent applications in the field of Fuel Cells. I am also an author and inventor of 13 publications describing unpatented inventions.

2. I have read and understood Lahiff, U.S. Patent Application Publication No. US 2003/0068538 A1 and Arnold et al., U.S. Patent No. 6,647,724. I understand and am familiar with the technology described in each of these two documents. While there are a few superficial similarities to my invention, the technologies described in the Lahiff and Arnold documents differ significantly in scope and spirit from my invention.

3. The Lahiff application teaches to operate a fuel cell system's electric motor-powered air compressor in a very inefficient manner to dissipate or waste excess electrical power generated by an electric vehicle's regenerative braking system. Electric vehicles typically have the ability to reverse the direction of energy flow in the vehicle's main drive or traction motor. Normally the main drive or traction motor converts electric power into mechanical torque to accelerate the vehicle. During vehicle braking or slowing conditions, the motor can reverse that process to convert mechanical torque to electric power that is typically stored in an on board battery or other electrical storage device. This is done to make the vehicle more energy efficient. Lahiff teaches that when more electrical energy is produced by this method than can be stored on board the vehicle this excess power is sent to the on board fuel cell's air compressor to be converted to mechanical energy as air pressure and flow. This air flow is dumped overboard using a system of valves bypasses the fuel cell stack. Alternately, Lahiff also teaches that if the minimum power request from the vehicle is lower than the minimum power that can be produced by the fuel cell system, the vehicle dissipates the excess power by sending to the air compressor, converting it

into air pressure and flow that it vents overboard. Lahiff does not teach or imply any mechanism to reclaim mechanical energy of the spinning compressor as our invention does. Only our invention reclaims this energy by regeneratively controlling the compressor motor of a fuel cell system to allow the reclaimed mechanical energy converted to electrical energy to be available to the compressor for the next increase in RPM or speed. Lahiff only teaches to run the compressor in an inefficient manner to waste energy, not to conserve it.

4. To quote the first line of the Lahiff abstract: “A method and apparatus for *dissipating energy* in a fuel cell generator system is provided.” (Emphasis added.) The Lahiff application does not state or imply using the compressor-motor unit to create or store electrical energy, only to dissipate excess electrical energy by converting it to air flow and pressure in the air compressor to then vent this flow and pressure overboard.

The Examiner’s statement on page 6 of the office communication dated 2/18/2009 that “So, the compressor of Lahiff et al. is certainly used to generate electricity as well as dissipate it” is not accurate. The Examiner then directs us to see the second sentence of [0011] of the Lahiff application. To quote the first three sentences of paragraph [0011] of Lahiff for context, Lahiff says, “According to one embodiment of the present invention, a method for dissipating electrical power output in a fuel cell power system is disclosed. The fuel cell power system includes a fuel cell stack for generating electric power and a compressor for delivering gas containing oxygen to the fuel cell stack. The method includes the steps of determining an amount of electrical power to be dissipated, operating the compressor to draw electrical current as required to dissipate the power, and valving the compressor to reduce the delivery of gas containing oxygen to the fuel cell stack.” I see no teaching or reference to the compressor being used to create or return

electrical power to the system, only to consume it. In the Lahiff fuel cell system, electric power is generated with either the vehicle regenerative braking system, or the fuel cell stack generates electric power, and that is by the chemical reaction of oxidant and fuel, not by regenerative control of the compressor motor to convert mechanical energy into electricity.

5. Arnold teaches to separate a typical 'turbocharger' component into two distinct halves, no longer connected by a common shaft as done on a typical turbocharged internal combustion (IC) application. A turbocharger is used to increase the specific output of an IC engine by raising the manifold air pressure (MAP) and air flow into the IC engine by powering a centrifugal air compressor impeller with an expander wheel on a common shaft converting energy contained in the exhaust gas stream to shaft power. Simply put, "more air + more fuel = more power" as shown in Fig. 7 of the Arnold Patent.

Arnold removes the common shaft between the compressor and expander wheels and replaces them with an electric motor to power the compressor and an electric generator powered by the turbine. Noting line 20 in column 4 of the Arnold Patent, it appears the added mass and complexity of the system is designed to provide instant 'boost' to an IC engine, overcoming the common 'turbo lag' issue of a typical turbocharger. Turbo lag refers to the time it takes for the turbo to 'spool up' and make boost relative to when the driver steps on the accelerator pedal.

To quote the Arnold Patent column 1, first paragraph "Subject matter disclosed herein relates generally to methods, devices, and/or systems for enhancing engine performance through use of an electrically driven compressor and/or turbine generator." The Arnold patent does not teach or imply to use an electrically driven compressor to convert mechanical energy into electrical energy.



6. The examiner makes several references on pages 6 and 7 of the Office communication dated 2/18/2009 to variable speed compressors and the teachings of Arnold in combination with, and in view of Lahiff. Every variable power or load following fuel cell system would have a variable electrical output, requiring a varying amount of oxidant air, hence variable speed compressor. Arnold's electrically driven variable speed compressor replaces a mechanically driven variable speed compressor. All turbocharged IC engines would have a variable speed compressor, whether powered by an exhaust driven turbine or a shaft or belt drive system from the IC engines crankshaft.

7. Any typical state-of-the-art fuel cell system uses a variable speed electric motor-driven air compressor to provide oxidant air to the fuel cell stack. It is unique to my invention to use that same component to capture the mechanical inertia of reducing its rpm, in response to lowering the power output level of the fuel cell, as electrical power so that this power can be available for the next increase in rpm corresponding to requesting an increase the electrical output of the fuel cell system.

The electric motor driven air compressor that supplies oxidant to a fuel cell stack should generally respond a load change request with an upward transient response time of 10-90% power in approximately 1-second. Therefore, the compressor must respond in similar fashion to supply the required oxidant for the power requested. This rapid response time can cause a short-term power drain several times the compressor motor's rated power. In addition, power is wasted when current is used to brake the motor on a down transient. My invention combats the power drain and assists with transient responses with an energy storage device (such as a

capacitor) and a control circuit added to the compressor motor controller to store braking energy during downward power transients, and release that energy to assist with the upward transients. This control scheme presents several advantages including faster system response and lower power drains on upward power transients. The capacitor can also be charged slowly under normal system operating conditions to keep it fully charged.

I do not find this invention to be obvious in reference to regeneratively braking a vehicle. This invention is used not to reclaim mechanical energy normally wasted by vehicular friction brakes. This invention is reclaiming the rotational energy of a motor driven air compressor to be stored in the compressor motor controlled to be used to increase the response time of the compressor at the next acceleration request. This also reduces the parasitic load of the compressor on the fuel cell stack, allowing the stack power to not be 'pulled down' by the compressor power request when the stack is concurrently creating electrical power to propel the electric vehicle it is contained in. Lahiff's regenerative vehicle braking does not, and cannot, have these features. Nor does Lahiff teach or suggest such features with his fuel cell system compressor.

9. I further declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true. I understand that willful false statements and the like if made herein would be punishable by fine or imprisonment, or both, under section 1001 of Title 18 of the United States Code, and may jeopardize the validity of the application or any patent issuing there from.

Joseph D. Rainville  
Joseph D. Rainville

Date: 16-APR-2009